CLASSIFICATION in IDIOPATHIC SCOLIOSIS

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ABSTRACT

Classification systems existing in idiopathic scoliosis either, try to explain structural deformity by means of different anatomy or they merge from the needs of treatment such as in defining and selection of fusion levels. Although, idiopathic scoliosis is a three dimensional deformity, at present there is no classification that addresses scoliosis in three dimentions.

In this article we reviewed existing classifications in choronological order.

Key words: *Idiopathic scoliosis, classification, sagittal profile.*

It's necessary to classify idiopathic scoliosis in order to allow comparison and prognostication of various patients. It's also important to identify fusion levels before surgery. Many classifications had been done and the first classification is anatomical classification. In this classification the major curve is more structural and deforming whereas a minor curve is less structural and deforming. This minor curve is called as compensatory curve (1).

Single major high thoracic curve

The upper vertebra of this curve is generally T1-T2 but rarely C7. It's called cervicotoracic curve. The high thoracic curve without a lower curve or with a flexible small curve below.

Single major thoracic curve

This kind of curve pattern is the most deforming one. Upper end vertebra is either at T4, 5, 6 and the lower end vertebra is at T11, 12 - L1, 2. The most common end vertebrae are T5 and T12. At lateral profile; the thoracic spine usually has decreased kyphosis or it is lordotic. This lordosis is the primary pathology in progressing scoliosis.

Single major thoracolumbar curve

The upper end vertebra is at T8, 9, 10 and the lower is at L3. Apex is at T12 or L1. This kind of curves is often associated with decompensation of the spine from the midline.

Major thoracic and minor lumbar curve

This pattern is most commonly seen, the upper end vertebra is at T4, 5 and lower end is at T12. In lumbar curve upper end is at T12 and lower end is at L4, 5. Lumbar curve is more flexible and thoracic curve is the structural one.

Double major thoracic and lumbar curve

Both curves appear at the same time, usually during juvenile years. Both of them are nearly at the same rigidity and degree. For this reason the spine is compensated and appearance of the patient is good. Thoracic apex is at T7, 8 and upper end is at T4, 5, 6; lower end at T10, 11, 12. Lumbar curve apex is at L1, 2 and lower end vertebra is at L4 or L5.

Double major thoracic and thoracolumbar curve

Thoracic curve is between T4 to T9, 10. Apex is at T6, 7. The thoracolumbar curve is between T9, 10 to L3 and apex is at T12-L1 disc space.

Double major thoracic curve

A left upper and right thoracic curve that the upper curve's apex is at T3, 4 and extends between T3, 4 to T5, 6. Lower one has its apex at in the thoracic spine and extends from T5, 6 to T11-L2. The upper curve may cause marked deformity and causes first rib elevation and associated with neck muscles and the shoulder.

Multiple curves

Travaglini was first described this deformity. Thi multiple curves are short and non deforming and occasionally require treatment.

Lumbosacral curves

This curves are compensatory to the upper curves and they are flexible.

This classification was commonly used until 1983

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that King described a new classification in idiopathic scoliosis. King and associates examined 405 patients' roentgenograms and defined 5 different thoracic idiopathic curve patterns. By understanding this curve patterns a selective fusion was described by King especially at type2 and type3 curves and this classification made surgical planning easier (9).

Type1: S-shaped curve in which both thoracic and lumbar curves cross the midline. Lumbar curve is larger than the thoracic curve and lumbar curve is less flexible than the thoracic when the thoracic curve is larger than the lumbar curve. Clinically the lumbar prominence is larger than the thoracic rib hump. Fig. 1.

Type2: S-shaped curve; both thoracic and lumbar curves cross the midline. Thoracic curve equal to or greater than lumbar curve. Lumbar curve more flexible than thoracic curve. Fig. 2.

Type3: This curve represents a true thoracic scoliosis. The side bending films show a highly flexible lumbar curve. Fig. 3.

Type4: Long thoracic curve in which L4 tilts into the thoracic curve. They generally show L5 balanced over the pelvis. Fig. 5.

Type5: Double thoracic curve with T1 tilted into convexity of upper thoracic curve and upper thoracic curve is structural on side bending. Fig. 5.

When King described this curves, he took only anterior plane into consideration. For this reason when selective fusion is done to the spine without giving importance to the sagital profile, decompensation is seen after surgery especially at type 2 and type 3 curves. Then some modifications are done to the type 2 and 3 curve patterns. Benon et al. (1) suggested subdividing type 2 curves into two subgroups.

Type 2a: Patients exhibited at least three of four criteria:

a) a lumbar curve < 35 degree.

b) a lumbar curve that corrects > 70% on side bending films.

c) lumar apical vertebra crossing the center sacral line.

d) a lumbosacral angle < 12 degree.

Type 2b: In this group; the patients demonstrated no more than two of these above criteria.

Type 3 1/2: (10) In type 3 curves, the second lumbar vertebra is usually the stable vertebra. When the third lumbar vertebra is the stable vertebra, the thoracic curve is classified as type 3 1/2.

By using 3 dimensional corrective devices, the sagital profile becomes more impartont. In King classification only one plane is considered but the idiopathic scoliosis is a three dimensioal deformity. Between 1983 to 1989 the studies of the Leeds group (Dickson et al.) showed that the median (sagital) plane asymmetry was the essential lesion that progress the deformity and in order to understand the pathology of the scoliosis sagital plane had to be investigated (2, 3, 4, 6, 7, 8). Also at surgery reconstruction of the sagital profile by three dimensional instruments reduce post operative imbalance that was shown at these studies. During their studies it became apparent that the accepted classifications of scoliotic curves was inadequate. By concerning the sagittal profile Dickson (2) explained another classification in 1989. Before describing this classification we have to analyze the biomechanics of the idiopathic scoliosis.

The mechanics of column failure or buckling are increasingly complicated when applied to a biologic system. To predict the behavior of any column of known shape and proportions, Euler's law (App. A) which describe that all loads on the column under analysis are vertical and centered over the column, are used. If a force applied to a rigid curved column in order to increase that curve, no lateral deviation or twisting will occur even if the force is increased until brittle failure occur (3). On the other and if the force applied in order to straighten the column, twisting and lateral bending will occur during the phase of plastic deformation. Most of the spine deformities can be described as the problems in long column stability where the term of stability can be described as the tendency of the spinal column to return to normal anatomic configuration. (14) The application of the Euler's laws to the spine is simple. If a kyphotic region of the spine is flexed forward, the intervertebral joints will allow the movement until fracture occurs. The spine has protect its contour and shape. On the other hand if a flexion is done to a fixed lordotic spine, it will behave like a curved column when it is stressed to unbend it. It will twist and rotate then scoliosis occur. When we ask a patient with a lordoscoliosis to touch her toes,this rotation will increase, this is the explanation of the clinical test of forward bending. (3,4,5) In 1905 Lovett (11) observed that lateral bending of the thoracic spine, when accompanied by flexion, was associated with coupled rotation of vertebral body. Normally, lateral flexion of the spine is coupled with rotation of the vertebral body into the concavity of the curve. But in contrast, when thoracic kyphosis decrease, convex vertebral rotation will occur. This pathology is seen similarly in thoracic idiopathic scoliosis. The loss of normal kyphosis and vertebral rotation in scoliosis were first described by Adams in 1865. Mac Lennan, Somerville (14) and later Roaf (13) have described that the hypokyphosis and rotation are the primary lesions of idiopathic scoliosis, with coronal plane asymmetry occuring only secondarily. According to Dickson, right thoracic idiopathic scoliosis is preceded by a loss of normal thoracic kyphosis which can happen during the adolescent growth acceleretion. This relative thoracic lordosis decreases vertebral resistance to deforming rotational forces. (2,3,4,5,6,7,8)

In his study (2,3), standard AP standing radiographs were taken and the rotation at each vertebral level was assessed by using Perdriolle torsiometer. If the posterior elements were turned to the right of the spine, rotation was recorded as positive. And negative if they turned to the left. Wedging was measured the inclination of the upper vertebral end plate from the horizontal at each level. Wedging was accepted positive when wedging created a curvature of the spine convex to the left and negative when convex to the right. Then rotation and wedging was multiplied at each level and the number was termed as the SAGİTAL SCORE (RotationXWedging). Bigger the score, the more lordotic segment is expected, and on the opposite; the kyphotic segment is expected. The sagital score was then adapted to the curves which were divided into 3 group which were true single, double, triple curves. 90 patients were examined. (2)

Single thoracic curves

Their apex were from T2 to T11. (especially at T7,8,9). This curves lordotic at apex and for one or two levels above and below. The lower limit of the curve was a short kyphosis at the thoracolumbar junction. At the upper limit of the curve normal upper thoracic kyphosis was present.

Single toracolumbar curves

Their apex were at T12 or L1 and lordosis were seen at apex and adjacent segments. One or two kyphotic segments were present at the lower part of the curve (L3-L4). In some of the curves there were also one or more kyphotic segments at the uppermost of the curve.

Single lumbar curves

Their apexes were at L2. All showed lordosis at L2 and kyphosis at L3-L4. A very few curves had kyphosis at the upper part of the curve.

Double thoracic-thoracic curves

The apex of the curve was at T3 or T4 and was smaller than the other. The lower apex was T7 to T11. All curves showed extensive lordosis.

Double thoracic-thoracolomber or thoracic-lumbar curves

They have a along lordosis extending from the mid-thoracic region through to the lumbar spine (T5, 6 to L4).

Triple thoracic-thoracic-lumbar or thoracic-thoracic-thoracolumbar curves

These curves had a small upper thoracic curves in thoracolumbar or lumbar curves. Lordosis were seen throughout the thoracic and lumbar spine.

In this study; it is shown that a short area of lordosis is balanced by kyphosis above and below to produce a single structural curve. If the lordotic area extends throughout the spine then there is no area for a balancing kyphosis to produce compensation for this reason compensation can only be done by developing a contralateral lordoscoliosis and this cause a production of a double structural curve.

Appendix A: The ability of a loaded structure, given an arbitrary small elastic deformation to return to its original position (Euler's Law).

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